Received: 4 September 2020 | Revised: 9 March 2021 | Accepted: 9 March 2021

DOI: 10.1002/vetr.305

Vet Record

ORIGINAL RESEARCH

Cardiac auscultation skills in final year veterinary students and recent veterinary graduates, referral hospital veterinary surgeons and veterinary cardiologists or cardiology residents

Deirdre Mullowney | **Virginia Luis Fuentes** | **Dominic Barfield**

Department of Clinical Science and Services, Royal Veterinary College, Herts, UK
(Email: vluisfuentes@rvc.ac.uk; dbarfield@rvc.ac.uk)

Correspondence
Deirdre Mullowney, Department of Clinical Science and Services, Royal Veterinary College, Hawkshead Lane, North Mymms, Herts AL97TA, UK.
Email: dmullowney7@rvc.ac.uk

[The copyright line for this article was changed on 28 April 2021 after first online publication].

Abstract

Background: Cardiac auscultation is an important part of the physical examination. This study evaluated cardiac auscultation skills in veterinary students and compared their abilities to recent veterinary graduates, referral hospital veterinary surgeons and veterinary cardiologists or cardiology residents. In addition it compared their self-predicted quiz scores to their actual scores, evaluating if they could accurately predict their own performance level.

Methods: A digital recording device was used to record auscultation sounds from 12 different patients with a diagnosis confirmed by a board-certified veterinary cardiologist. The sound files and associated phonocardiograms were uploaded to a video sharing website. A cloud-based online multiple-choice quiz was generated and shared with final year veterinary students, recent veterinary graduates, referral hospital veterinary surgeons and veterinary cardiologists or cardiology residents.

Results: There were 128 participants: 51 final year veterinary students, 62 recent veterinary graduates, and 10 referral hospital veterinary surgeons and five veterinary cardiologists or cardiology residents. No difference was found between the cardiac auscultation skills of recent veterinary graduates and final year veterinary students. Veterinary students' self-predicted scores were lower than actual scores.

Conclusions: Recent veterinary graduates did not perform better than final year veterinary students in this study, suggesting that auscultation skills do not continue to improve in the first few years after graduation. Efforts should be made to maximise students' learning in cardiac auscultation skills. Veterinary students show a lack of confidence in cardiac auscultation skills.

INTRODUCTION

Cardiac auscultation is an important aspect of a physical examination. Studies have looked at the significance of cardiac murmurs in relation to cardiac disease.[1–4] Studies have documented a link between severity of murmur and severity of stenosis in cases of diagnosed subaortic stenosis or pulmonic stenosis.[15] A retrospective study of dogs with myxomatous mitral valve disease also showed that disease severity increased with murmur intensity.[2] Murmur grade in dogs with myxomatous mitral valve disease has been shown to predict outcome.[3] The American College of Veterinary Internal Medicine (ACVIM) consensus statement guidelines for the classification, diagnosis and management of cardiomyopathies in cats recommends further investigations if a heart murmur is detected in any cat.[6]

The ability to effectively perform cardiac auscultation is important in routine clinical examinations. To the authors' knowledge, there are no prior studies of companion-animal auscultation skills in veterinary students. The ability of veterinarians and veterinary students to recognize and interpret specific auscultatory events using digitally recorded equine heart sounds has been investigated. In this study, diplomates made a correct diagnosis on 53% of occasions, whereas practitioners and veterinary students did so only on 33% and 29% of occasions, respectively.[7] Cardiologists and internists have been compared in human medicine and found that cardiac auscultatory proficiency for common valvular lesions was similar in both groups; however cardiologists performed better than internists when auscultating more rare cardiac lesions.[8] A large multicentre study of 318 students, 289 residents, 85 cardiology fellows, 131 physicians and 37 other doctors found that cardiac examination skills do not improve after the third year of training and may decline after years in practice.[9] The Dunning Kruger effect is a term used in human psychology to describe a cognitive bias whereby incompetent people are unable to recognise that they are incompetent, described as 'illusory superiority'. Incompetence not only causes poor performance but also the inability to recognize that one's performance is poor. Conversely, competent people tend to underestimate their ability and test performance relative to their peers, thereby failing to realize that their proficiency is not necessarily shared by their peers. This is described as 'The Burden of Expertise'.[10,11] To the authors' knowledge, there is no research into the presence of this phenomenon in veterinary education and practice.

The aims of this study were to compare cardiac auscultation skills between final year veterinary students, recent veterinary graduates, referral hospital veterinary surgeons and veterinary cardiologists or cardiology residents and to investigate the ability of these groups to assess their own performance. Our hypothesis was that cardiac auscultation skills would improve with practice, and so the recent veterinary graduates would perform better than students at identifying heart sounds in the quiz. We also hypothesized that the undergraduate students would suffer from a cognitive bias of illusory superiority and overestimate their performance in the quiz.

MATERIALS AND METHODS

A cross sectional study was carried out to evaluate the cardiac auscultation abilities of final year veterinary students, recent veterinary graduates, referral hospital veterinary surgeons and veterinary cardiologists or cardiology residents. Canine and feline heart sounds were recorded using a digital stethoscope.[*] All heart sounds were recorded from patients referred to the Queen Mother Hospital for Animals, The Royal Veterinary College. Owner consent for participation in research was obtained. Ethical approval was obtained from the authors' institution (URN 2021-2023-2R and URN SR2017-1185).[†] In all cases the presence and type of heart disease (or absence of cardiac disease) had been confirmed with auscultation, echocardiography and electrocardiography by a board-certified cardiologist. Recordings were edited using an audio editor[‡] to normalize and reduce noise. The .wav files were then embedded into a quiz using an online quiz development cloud-based software, together with an image of the corresponding sound waveform to represent phonocardiograms.[§] The quiz consisted of 15 questions in total: the first question asked the participant to identify themselves as either a final year veterinary student, a recent veterinary graduate, referral hospital veterinary surgeons or a veterinary cardiologist or cardiology resident; there were 12 questions on auscultation recordings; and two questions regarding self-predicted performance. The questions were multiple choice with one correct answer and three distractors. Auscultation recordings were approximately 2 min duration and looped and included a phonocardiogram but no information regarding species, signalment or case history. A link to the quiz is provided in the additional information section. A veterinary student was defined as a final year veterinary student studying at the authors' institution. A recent veterinary graduate was defined as a veterinary surgeon who had qualified in the previous 2 years. Referral hospital veterinary surgeons were defined as an intern or non-cardiology resident/senior clinician at the authors' institution. A veterinary cardiologist was defined as a board-certified cardiologist or cardiology resident at any stage of training. Participants were not required to provide evidence of their status. Participants were advised to complete the quiz using headphones in a quiet environment. Informed consent for participation in research was obtained. An email with the link to the quiz was sent to all final year students at the authors' institution. A deadline for completion of the quiz was not specified, although the quiz was available for a total of 6 months after which time the online quiz was closed, and data collection and analysis were performed. The quiz was also shared with recent veterinary graduates from any university through closed veterinary groups on social media. Respondents were anonymous, and there was no incentive for participation.

Statistical analysis

Data from the online quiz development cloud-based software were transferred to a spreadsheet[**] and subsequently analysed in a statistical software package.[††] A Shapiro-Wilk test was used to assess for normality. Wilcoxon signed rank test was used to compare self-predicted scores and actual scores for each group. Overall score results were compared between the four groups using a Kruskal-Wallis test. Results for individual questions between groups were compared using Fisher's exact test. Bonferroni's correction was done

TABLE 1 Fishers exact test was used to compare results for individual questions between four groups. Student, final year veterinary students; recent graduate, recent graduate veterinary surgeons; referral vet, referral hospital veterinary surgeons; cardiologist, veterinary cardiologists or cardiology residents

	Student	Recent graduate	Referral vet	Cardiologist	*p* Value
Systolic murmur-possible differential is pulmonic stenosis	16/51 (31.3%)	15/62 (24.1%)	5/10 (50%)	3/5 (60%)	0.151
Machinery murmur consistent with patent ductus arteriosus	16/51 (31.3%)	21/62 (33.8%)	7/10 (70%)	2/5 (40%)	0.121
Gallop sound in a cat	20/51 (39.2%)	31/62 (50%)	6/10 (60%)	5/5 (100%)	**0.049**
Normal cat heart sound	26/51 (50.9%)	38/62 (61.2%)	6/10 (60%)	2/5 (40%)	0.619
Harsh holosystolic murmur consistent with ventricular septal defect	28/51 (56.8%)	37/62 (59.6%)	9/10 (90%)	4/5 (80%)	0.216
Loud diastolic murmur consistent with aortic insufficiency	30/51 (58.8%)	40/62 (64.5%)	7/10 (70%)	5/5 (100%)	0.361
Arrhythmia consistent with 3rd degree atrioventricular block	32/51 (62.7%)	40/62 (64.5%)	6/10 (60%)	4/5 (80%)	0.922
Normal heart sounds	36/51 (70.5%)	35/62 (56.4%)	7/10 (70%)	5/5 (100%)	0.153
Tachycardia and arrhythmia consistent with atrial fibrillation	38/51 (74.5%)	40/62 (64.5%)	9/10 (90%)	4/5 (80%)	0.339
Loud systolic murmur	39/51 (76.4%)	52/62 (83.8%)	9/10 (90%)	5/5 (100%)	0.626
Sinus arrhythmia	41/51 (80.3%)	39/62 (62.9%)	9/10 (90%)	5/5 (100%)	0.055

for post hoc comparison. Median (25th, 75th percentile) was used to summarise the scores. Statistical significance was set to a p value < 0.05.

RESULTS

Of 237 final year veterinary students who were sent the link to the quiz, 71 started the quiz and 51 completed the quiz. One hundred recent veterinary graduates started the quiz, and 62 completed it. Ten referral hospital veterinary surgeons started the quiz, and 10 completed it. Five veterinary cardiologists or cardiology residents at the authors' institution also completed the quiz. Results are presented in Table 1. The median score for final year veterinary students was 6.0 (6.0, 7.0), and the median score for recent veterinary graduates was 6.0 (5.0, 7.0). The median score for veterinary cardiologists or cardiology residents was 9.0 (7.5, 10.0), while the median score for referral hospital veterinary surgeons was 8.5 (6.8, 9.2). There was a significant difference between all four groups' score results ($p = 0.001$), but post-hoc pairwise comparisons of scores for final year veterinary students and recent veterinary graduates showed no significant difference ($p > 0.999$). The scores were higher for veterinary cardiologists including cardiology residents than for final year veterinary students ($p = 0.023$). During final review, one auscultation recording was considered to be of poor quality, and for analysis of overall test performance, this question was removed. This question was included in comparison of self-predicted and actual test scores. When analysing individual heart sounds, the group including veterinary cardiologists and cardiology residents was better at identifying a gallop sound in a cat ($p = 0.049$). The most easily identifiable auscultation abnormality was a loud systolic murmur with 39 of 51 (76%) final year veterinary students, 52 of 62 (84%) recent veterinary graduates and five of five (100%) veterinary cardiologists or cardiology residents correctly identifying this auscultation abnormality. The least identifiable auscultation abnormality was a systolic murmur with a possible differential of pulmonic stenosis, which was correctly identified by 16 of 51 (31.3%) final year veterinary students, 15 of 62 (24.1%) recent veterinary graduates, five of 10 (50%) referral hospital veterinary surgeons and three of five (60%) veterinary cardiologists or cardiology residents. Distractors for this question were 'normal heart sound' which was selected by three of 51 final year veterinary students and one of 62 recent veterinary graduates, 'machinery murmur consistent with patent ductus arteriosus' which was selected by 29 of 51 final year veterinary students and 44 of 62 recent veterinary graduates and 'irregular rhythm – possible differential bigeminy' which was selected by three of 51 final year veterinary students and two of 62 recent veterinary graduates.

When comparing overall scores for each participant, there was a significant difference between the median self-predicted score and the median actual score for final year veterinary students, with 34 of 51 having a higher actual score than self-predicted score, 10 of 51 having a lower actual score than self-predicted score and seven of 51 correctly predicting their score ($p < 0.001$). There was no difference between the median actual score and the median self-predicted score for recent veterinary graduates, with 33 of 62 having higher actual score than self-predicted score, 23 of 62 having lower actual score than self-predicted score and six of 62 correctly predicting their score ($p = 0.177$). There was no difference between the median actual score and the median self-predicted score for referral hospital veterinary

surgeons, with six of 10 having higher actual score than self-predicted score, two of 10 having lower actual score than self-predicted score and two of 10 correctly predicting their score (p = 0.139). There was no difference between the median actual score and the median self-predicted score for veterinary cardiologists or cardiology residents, with two of five having higher actual score than self-predicted score, zero of five having lower actual score than self-predicted score and three of five correctly predicting their score (p = 0.157).

DISCUSSION

The results of this study show that final year veterinary students lack confidence in their ability to accurately identify abnormal heart sounds and underestimate their cardiac auscultation skills. Recent veterinary graduates did not score more highly than final year veterinary students, which suggests that cardiac auscultations skills may not improve in the first 2 years after graduation. Although recent veterinary graduates were better able to predict their performance, both final year veterinary students and recent graduate veterinary surgeons had low self-predicted scores, indicating a lack of confidence in cardiac auscultation. This identifies an area for development in clinical teaching of undergraduate and postgraduate veterinary students.

The ability to perform a complete clinical examination is listed in the Royal College of Veterinary Surgeons' essential competencies required of the new veterinary graduate 'day one skills'.[12] A thorough cardiac auscultation is an essential part of a complete clinical exam, and accurate identification of abnormal heart sounds may aid recognition of underlying heart disease.[13,14] Annual auscultation is cited as an important monitoring tool in the ACVIM consensus statement on guidelines for the diagnosis and treatment of canine myxomatous mitral valve disease.[15] This recommendation is based on the assumption that the veterinary surgeon performing the clinical examination can adequately identify and classify the murmur. Both recent veterinary graduate and final year veterinary students performed reasonably well at identifying a 'loud systolic murmur', with 76.4% of final year veterinary students and 83.8% of recent veterinary graduates identifying this sound correctly. This suggests that final year veterinary students and recent veterinary graduates are more likely to identify a loud murmur of mitral regurgitation than some of the other heart sounds assessed in this study.

This study highlighted a lack of ability to accurately identify congenital cardiac disorders which may benefit from early intervention. For example, in a study of 55 dogs diagnosed with pulmonic stenosis in which balloon valvuloplasty or surgery was not pursued, seven dogs (13%) had a cardiac cause of death.[16] Although some dogs with pulmonic stenosis may present with clinical signs of syncope or exercise intolerance, a third of affected patients may be asymptomatic at presentation.[16] This highlights the importance of being able to identify systolic murmurs associated with pulmonic stenosis in order to allow for early intervention. Thirty one percent of final year veterinary students and 24% of recent veterinary graduates accurately identified a recording of a dog with pulmonic stenosis that was labelled 'systolic murmur - possible differential is pulmonic stenosis'. Although most final year veterinary students and recent veterinary graduates did not correctly identify pulmonic stenosis based on cardiac auscultation, very few participants considered this to be a normal heart sound and so still might have considered referral or sought advice from a more experienced colleague. To address the lack of confidence in auscultation skills in final year veterinary students and recent veterinary graduates reported here, consideration should be given to increasing access to digital cardiac recordings in the teaching of companion animal auscultation.

It was challenging to obtain heart sounds of a reliable quality using the available software. A digital recording of a heart sound will arguably never be the same as cardiac auscultation with a stethoscope. No clinical information or history was provided in the quiz, and answers were based purely on cardiac auscultation, which also does not mirror real life auscultation. The authors chose not to provide clinical information in an attempt to minimise confirmation bias. Although caution must be taken applying results of this study to real life auscultation skills of veterinary students and recent veterinary graduates, these results contribute to the knowledge base of cardiac auscultation in veterinary medical education and furthermore provides information regarding veterinary students and recent veterinary graduates' ability to assess their own performance. Phonocardiograms were also provided, which might have influenced results as a visual representation of the heart sounds could have influenced the participants' interpretation of the sound. However, interpretation of phonocardiograms was not the primary aim of this study. Although candidates were advised to listen to the heart sounds using good quality earphones in a quiet environment, there was no standardised setting in which candidates took the quiz. This might explain why the veterinary cardiologists or cardiology residents performed less well than expected in this quiz. The number of veterinary cardiologists or cardiology residents participating in this study was low, making it difficult to draw conclusions regarding their performance in the quiz but there was no difference between self-predicted and actual results for veterinary cardiologists or cardiology residents which suggests that this group was accurately able to predict their performance and potentially adjusted their self-predicted scores to accommodate for the effect of listening to a recording rather than a live patient.

The quiz was sent to all final year veterinary students at the author's institution, and it is possible that students with an interest in cardiology would have

been more likely to complete the quiz. The quiz was shared with all final year veterinary students, but some students had not started their rotations in the Queen Mother Hospital for Animals and might not have been auscultating patients regularly. As the cardiology rotation is not compulsory, it is also possible that students who had spent time in the cardiology service might have had superior cardiac auscultation skills compared to their peers. To reach as many recent veterinary graduates as possible the quiz was shared widely on social media, and so there is no way of knowing how many people received a link to the quiz or whether the recent veterinary graduates who took the quiz had a special interest in cardiology. Furthermore, participation in the quiz was open to a large audience, and although the quiz was shared on closed veterinary groups on social media, it is theoretically possible that others could have participated. Participants were not required to provide evidence of their status, and it is possible that participants incorrectly identified themselves. Because participation in the quiz was not regulated, it is possible that the quiz was not only taken by intended groups but obtaining proof of status might have compromised anonymity. There was also a small potential for overlap between the groups, as participants might have identified as both a referral hospital veterinary surgeon and a cardiologist or cardiology resident. Participants were asked to select the category that best described them.

The second aim of this study was to investigate whether veterinary surgeons and final year veterinary students could adequately assess their own performance. Final year veterinary students lacked confidence in their ability to identify heart sounds, with 67% of participants underestimating their performance in this quiz. Although individual participants may have overestimated their performance in this quiz, there was an overall trend for students to have higher scores than their self-predicted scores. In this study, there was no evidence of an illusory superiority, which appears to affect some young professionals' ability for self-assessment.[17] The ability to assess one's skills and identify areas for further improvement is an important skill for veterinary surgeons, and there are few studies examining this. Results from social psychology literature suggest that people tend to have flawed self-assessment skills and tend to over-estimate their own abilities.[10,11,17–19] In a previous study, veterinary students were asked to self-assess their competence in the areas of knowledge, clinical skill and professionalism, and these self-assessment results were compared to assessment by supervising faculty. Low-performing veterinary students were more likely to overestimate their competence levels than higher-performing students.[20] Psychologists have commented on the tendency of people to describe themselves as 'above average'. This could be explained by the tendency of students to focus on their own skills and insufficiently take into account the skills of the comparison group. This was not a feature of our study with 40 of 51(78%) final year veterinary students ranking themselves as either 'bottom quartile' or 'below average'. Further research is required to confirm this observation in other aspects of veterinary medicine and to assess the impact of this on professional practice and continued professional development.

CONCLUSIONS

Cardiac auscultatory proficiency was not different between recent veterinary graduates and final year veterinary students. There was no difference between self-predicted and actual scores for recent veterinary graduates, suggesting that members of this group are accurate at predicting their own abilities in cardiac auscultation. In contrast, veterinary students' self-predicted scores were lower than actual scores, suggesting a lack of confidence in this group's cardiac auscultation skills.

ORCID

Deirdre Mullowney https://orcid.org/0000-0002-6470-5910

Dominic Barfield https://orcid.org/0000-0003-4058-2781

Notes

* eKuore Vet basic Kit electronic veterinary stethoscope (first generation), eKuroe, Spain.
† Social Sciences Research Ethical Review Board (SSRERB) approval: URN 2021-2023-2R and URN SR2017-1185.
‡ Audacity Team (2018). Audacity(R): Free Audio Editor and Recorder (Computer application). Version 2.3.0.
§ Surveymonkey.com
** Microsoft Excel.
†† SPSS V.20; SPSS.

ACKNOWLEDGEMENTS

The authors would like to thank Julie Kavanagh and the rest of the Cardiology Service at The Royal Veterinary College, the veterinary surgeons and undergraduate students who participated in the quiz, Sonya Powney for assistance with creating the quiz and Yu Mei Chang for help with statistics.

CONFLICT OF INTEREST

Virginia Luis Fuentes is a co-investigator on a KC Charitable Trust-funded project evaluating electronic heart sounds. No other authors of this article have a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

ADDITIONAL INFORMATION

The original quiz is available at https://www.surveymonkey.com/r/XDLZQP2

AUTHOR CONTRIBUTIONS

Deirdre Mullowney, Dominic Barfield and Virginia Luis Fuentes all contributed to the study design.

Deirdre Mullowney acquired and analysed the data, and all authors provided critical feedback, analysis and interpretation as well as final approval of the manuscript.

REFERENCES

1. Caivano D, Dickson D, Martin M, Rishniw M. Murmur intensity in adult dogs with pulmonic and subaortic stenosis reflects disease severity. J Small Anim Pract. 2018;59(3):161–6.
2. Ljungvall I, Rishniw M, Porciello F, Ferasin L, Ohad DG. Murmur intensity in small-breed dogs with myxomatous mitral valve disease reflects disease severity. J Small Anim Pract. 2014;55(11):545–50.
3. López-Alvarez J, Elliott J, Pfeiffer D, Chang YM, Mattin M, Moonarmart W, et al. Clinical severity score system in dogs with degenerative mitral valve disease. J Vet Intern Med. 2015;29(2):575–81.
4. Nakamura RK, Rishniw M, King MK, Sammarco CD. Prevalence of echocardiographic evidence of cardiac disease in apparently healthy cats with murmurs. J Feline Med Surg. 2011;13(4):266–71.
5. Kvart C, French AT, Luis Fuentes V, Häggström J, Dukes Mcewan J, Schober KE. Analysis of murmur intensity, duration and frequency components in dogs with aortic stenosis. J Small Anim Pract. 1998;39(7):318–24.
6. Luis Fuentes V, Abbott J, Chetboul V, Côté E, Fox PR, Häggström J, et al. ACVIM consensus statement guidelines for the classification, diagnosis, and management of cardiomyopathies in cats. J Vet Intern Med. 2020;34(3):1062–77.
7. Naylor JM, Yademuk LM, Pharr JW, Ashbumer JS. An assessment of the ability of diplomates, practitioners, and students to describe and interpret recordings of heart murmurs and arrhythmia. J Vet Intern Med. 2001;15(6):507–15.
8. Sztajzel JM, Picard-Kossovsky M, Lerch R, Vuille C, Sarasin FP. Accuracy of cardiac auscultation in the era of Doppler-echocardiography: A comparison between cardiologists and internists. Int J Cardiol. 2008;138:308–10.
9. Vukanovic-Criley JM, Criley S, Warde CM, Guevara-Matheus L, Churchill WH, Nelson WP, et al. Competency in cardiac examination skills in medical students, trainees, physicians, and faculty: A multicenter study. Arch Intern Med. 2006;166:610–6.
10. Dunning D, Dunning D, Heath C, Heath C, Suls JM, Suls JM. Implications for health, education, and the workplace. Psychol Sci Public Interes. 2004;5(3):69–106.
11. Kruger J, Dunning D. Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. J Pers Soc Psychol. 1999;77(6):1121–34.
12. Eraut M, Boulay B. RCVS VN day one competences. London: RCVS; 2014.
13. Ettinger SJ, Feldman EC. Textbook of veterinary internal medicine. 8th ed. St. Louis, MO: Elsevier; 2010.
14. Côté E, Edwards NJ, Ettinger SJ, Fuentes VL, MacDonald KA, Scansen BA, et al. Management of incidentally detected heart murmurs in dogs and cats. J Vet Cardiol. 2015;17(4):245–61.
15. Atkins C, Bonagura J, Ettinger S, Fox P, Gordon S, Haggstrom J, et al. Guidelines for the diagnosis and treatment of canine chronic valvular heart disease. J Vet Intern Med. 2009;23(6):1142–50.
16. Johnson MS, Martin M, Edwards D, French A, Henley W. Pulmonic stenosis in dogs: balloon dilation improves clinical outcome. J Vet Intern Med. 2004;18;656–62.
17. Austin Z, Gregory PAM. Evaluating the accuracy of pharmacy students' self-assessment skills. Am J Pharm Educ. 2007;71(5):1–8.
18. Schlösser T, Dunning D, Johnson KL, Kruger J. How unaware are the unskilled? Empirical tests of the "signal extraction" counterexplanation for the Dunning-Kruger effect in self-evaluation of performance. J Econ Psychol. 2013;39:85–100.
19. Dunning D, Heath C, Suls JM. Flawed implications for health, education, and the workplace. Psychol Sci Public Interes. 2011;5(3):69–106.
20. Root Kustritz MV., Molgaard LK, Rendahl A. Comparison of student self-assessment with faculty assessment of clinical competence. J Vet Med Educ. 2011;38(2):163–70.

How to cite this article: Mullowney D, Fuentes VL, Barfield D. Cardiac auscultation skills in final year veterinary students and recent veterinary graduates, referral hospital veterinary surgeons and veterinary cardiologists or cardiology residents. *Vet Rec.* 2021;e305. https://doi.org/10.1002/vetr.305